Appendix G - Silvicultural Systems

Background

The Report of the Committee on Agriculture and Forestry United States Senate on the National Forest Management Act of 1976, to accompany S. 3091, pages 36, 37 states:

> "In recognition of the fact that forests are extremely diverse, the Committee concluded that there are many factors which must be considered in selecting the proper silvicultural system in order to meet management objectives under plans. Therefore, the committee directed that the silvicultural systems to be prescribed should be appropriate to the forest type and represent the current state-of-the-art in scientific forest management.
>
> In carrying out this provision, the Committee expects that the Secretary will identify, for the logical geographical areas, the silvicultural system or systems which have been found through research and experience to provide conditions for the prompt regeneration and growth of desirable tree species in order to meet multiple-use objectives set forth in the forest land management plan. It is recognized that silviculture can be utilized to achieve a variety of management objectives, in addition to that of timber production, wildlife, watershed, recreation, grazing, protection of the forest from insects and disease, and other multiple-use objectives can be advanced through application of various silvicultural methods and cutting techniques. All such uses and applications should be considered in the development of silvicultural prescriptions. In developing the prescriptions, the Secretary is expected to utilize findings of research by the Forest Service, as well as other sources and to consult with the committee of scientists established by the bill. In prescribing silvicultural systems, the Secretary will consider all resource objectives for the area as well as environmental factors, including economic and social impacts."

The implementing regulations of the National Forest Management Act require Regional Foresters to establish standards and guidelines for harvest cutting methods; the maximum size, dispersal and size variation of tree openings created by even-aged management; the state of vegetation that will be reached before a cut-over area is no longer an opening; and defining management intensities and utilization standards to be used in determining harvest levels. (36 CFR 219.9)

These regional standards and guidelines have been published in the Final Supplemental Environmental Impact Statement for Regional Guide Amendment. Some of that information is included here to help the reader understand the major tree species or forest cover types on the Forest.

Forest cover types modeled for the forest growth and yield tables are lodgepole pine, Engelmann spruce/subalpine fir, and aspen. These three types make up the vast majority of species for the Forest. Other species present on the Forest, but not significant enough to model include, but are not limited to, limber pine, Douglas-fir, and ponderosa pine.

Engelmann Spruce/Subalpine Fir Forests

Engelmann spruce and subalpine fir (the spruce/fir forest) are widely distributed in Colorado, Wyoming, and South Dakota and generally occur as the highest elevation forest type, normally extending to timberline. Spruce/fir forests include bristlecone pine, limber pine, lodgepole pine, Douglas-fir, and aspen, but the forest environment is dominated by Engelmann spruce and subalpine fir.

Engelmann spruce and subalpine fir tend to cover a well-defined altitudinal zone ranging from 9,000 to approximately 12,000 feet.

Spruce-fir forests grow in cold, humid climatic zones. These forests experience extremely short, frost-free periods, usually lasting 60 days or less. Annual average precipitation ranges between 20 and 35 inches.

Engelmann spruce and subalpine fir are capable of forming stable stands. They are probably the most successful coniferous trees in the Rocky Mountains in terms of establishing new generations under the influence of their own shade. These species tend to maintain themselves on a site until changed by an external force such as fire. When fire occurs, spruce and fir are often replaced by lodgepole pine, aspen, or grassy parks, which slowly trend toward the climax spruce/fir community if left undisturbed. Lodgepole pine, aspen, limber pine, and bristlecone pine are, in most cases, seral species of the spruce/fir community if left undisturbed. Lodgepole pine, aspen, limber pine, and bristlecone pine are, in most cases seral species of the spruce/fir community at higher elevations on better soils. On sites too dry for Engelmann spruce or subalpine fir, lodgepole pine and aspen form stable stands within the general Engelmann spruce/subalpine fir forest.

Artificial regeneration with spruce has proven to be difficult in some parts of the Rocky Mountains. High light intensities and temperature extremes cause seedling mortality.

Fir seedlings become established on a variety of seedbeds and do well in deep shade. Subalpine fir is very tolerant of shade, allowing it to exist in the understory of Engelmann spruce stands.

Both Engelmann spruce and subalpine fir seedlings grow slowly. Because spruce and fir grow on moist, cool sites, they typically have very shallow, short roots. For this reason, both species are very susceptible to windthrow, especially if stands are suddenly opened extensively by timber harvest. Usually no more than 30 to 40% of the basal area should be removed in order to prevent windthrow. Because trees develop interdependence for protection from the wind, care is exercised when trees are to be removed.

Engelmann spruce is susceptible to the spruce bark beetle which attacks older, larger, less vigorous trees. Infestations commonly occur in groups of trees on more moist sites. Engelmann spruce is also vulnerable to numerous wood rotting fungi which either kill the tree or cause it to break or fall. Subalpine fir is highly susceptible to rot and has a much shorter pathological age of maturity than does Engelmann spruce.

Given the shade tolerance of Engelmann spruce and subalpine fir, coupled with susceptibility to insects, disease, and blowdown, many stands develop more than one age class and may become uneven-aged stands. Depending on how they develop, stands can be one, two, three, or multi-storied. Regeneration occurs almost continuously throughout the stand in openings resulting from blowdown or insects infestation. This accounts for the clumpy structure in many old-growth stands.

Lodgepole Pine Forests

Lodgepole pine forests are composed of only one tree species, lodgepole pine. These forests occur mainly in the drier coniferous regions, but also can be found in very dry (xerophytic) conditions and in the subalpine coniferous region. Lodgepole pine is associated with numerous forest types, including Engelmann spruce/subalpine fir, ponderosa pine, Douglas-fir, and aspen.

Lodgepole pine is distributed uniformly throughout Wyoming and northern Colorado and sporadically in central Colorado. Researchers have found some lodgepole pine in the Black Hills of South Dakota. Because the tree species has a broad range of temperatures and moisture tolerance, it can be found everywhere from the warm, dry, lower elevations, associated with ponderosa pine, to the cool, moist, higher elevation zones. Lodgepole pine forests range between less than 8,000 feet to over 10,500 feet in elevation.

The climate affecting lodgepole pine forests is variable. Average annual precipitation ranges from 15 to 30 inches, with higher elevations receiving more precipitation than lower elevations. The growing season is generally short, averaging between 60 to 100 days in most areas. Mean annual temperatures are between 30 and 40 degrees Fahrenheit.

Lodgepole pine typically occurs as a pure stand and is frequently very dense. Although it is sometimes invaded and eventually replaced by other conifers, lodgepole pine more often appears as a stable climax species.

Mountain pine beetles are the most serious insect threat to old-growth lodgepole pine stands. Outbreaks generally reach epidemic proportions only in stands where older trees, 14 inches in diameter and larger, are present.

Dwarf mistletoe is the most serious disease affecting lodgepole pine forests. Dwarf mistletoe reduces growth and increases the mortality of these trees. Because the disease propagates by shooting spores to adjacent branches, it is extremely difficult to control dwarf mistletoe in uneven-aged lodgepole pine stands which exhibit vertical structure. The profusion of branches and different size trees in uneven-aged stands makes it very easy for the disease to spread quickly through such stands.

Lodgepole pine bears an abundance of serotinous cones. However, it is not uncommon to have both serotinous and non-serotinous cones in the same stand. In stands with serotinous cones, the most important form of seed dispersal is release from cones attached to slash or cones scattered on the forest floor. Maximum release from this source takes place the first year after disturbances such as fire or timber harvest. In stands with non-serotinous cones, seed is dispersed from standing trees, largely by the wind.

Aspen Forests

Aspen is a deciduous tree. It is frequently associated with and lies between coniferous forests (Douglas-fir, Engelmann spruce/subalpine fir, lodgepole pine, and ponderosa pine) and mountain grassland parks and meadows.

Aspen is widely distributed throughout Colorado, Wyoming, and South Dakota. It is best developed in the central and southwestern areas of Colorado and southern Wyoming, where trees often reach 24 inches in diameter and 100 feet in height. In the Rocky Mountain Region, aspen occurs at elevations ranging between 6,000 to 10,500 feet.

Annual precipitation ranges from 15 to 40 inches and mean annual temperatures average between 30 and 40 degrees Fahrenheit in most areas.

Although aspen can reproduce from seed, it most commonly regenerates from sprouts (suckers) that originate from its carbohydrate-rich root system. Suckers are stimulated by increased soil and root temperatures caused by increasing exposure to sunlight. Because many of the suckers develop from a single, interconnected root network, aspen stands are normally composed of an aggregate of groups of genetically identical individuals called clones.

Although clonal characteristics affect stand structure, varying situations can cause aspen trees to grow in even-aged, two-storied, or uneven-aged stands. Uneven-aged stands can develop from repeated fires in which not all of the trees are killed. A similar situation can result when individual trees are killed or when individual trees die from old age, insects, or diseases. Even-aged stands result from a major disturbance such as intense fire or clearcutting.

In the absence of disturbances which would stimulate regeneration, stands will normally deteriorate and die. Conversions to associated types require varying amounts of time which depend on a number of factors, such as the frequency of fire, the extent and intensity of browsing, disease, stand density, and altitude.

Aspen is generally very intolerant to shade and must have full sunlight to grow and reproduce. It is less shade tolerant than any of the species with which it is normally associated.

Aspen is highly susceptible to many diseases. Decay fungi cause the greatest losses and are responsible for shortening the rotation age. Except for isolated cases, insects are not normally a major problem in aspen.

Silvicultural Systems

"The silvicultural system can be viewed as the process by which we grow a forest stand for a specific purpose. This process includes all practices over a rotation--harvest or regeneration cuttings, intermediate cuttings, and other cultural treatments--necessary for replacement and development of the forest stand." (Burns 1983, p.1)

The two main types of silviculture systems in use on the Routt National Forest are the even-aged and uneven-aged systems. Under the even-aged system, clearcutting, shelterwood, and coppice regeneration methods have been used. Under the uneven-aged system, the single tree and group selection regeneration methods have been used.

The two-aged system is also used on the Forest but not to any great extent. Under the two-aged system, irregular shelterwood regeneration methods have been used. Refer to the Glossary for a definition of two-aged methods and the types of methods included in the two aged system.

> Systems for proposed use in spruce/fir are the two-step, three-step, irregular shelterwood, and individual and group tree selection.
>
> Systems for proposed use in lodgepole pine are clearcutting, two-step shelterwood, irregular shelterwood, and group selection.
>
> Systems for proposed use in aspen are coppice and group selection.

Clearcutting

Clearcutting harvests all merchantable trees and regenerates the entire stand at one time. "Reproduction is obtained by natural seeding from adjacent stands or from trees cut in the clearing operation, or it is obtained artificially through planting or direct seeding." (USDA May 1992b, p.II-3). "Clearcutting is aesthetically the least desirable of the harvest methods. However, the undesirable appearance of the harvested area is temporary and can be improved through careful location of boundaries to fit the landscape, minimizing the acreage to be cut, appropriate cleanup of logging debris, and prompt establishment of reproduction." (Burns 1983, p.2). "Clearcutting silviculture is the most appropriate system for effectively regenerating those species of trees which naturally grow in even-aged stands and which cannot regenerate in the stand of other trees. Aspen and lodgepole are these kinds of trees." (USDA May 1992b, p.ii).

"Clearcutting silviculture has a very important environmental implication for forests in the Rocky Mountain Region. Clearcutting silviculture is done in such a way that trees are logged in an area and then left to grow for a relatively long period of time. This means that roads can be built and then closed to traffic or physically removed and the land restored, and that mechanical equipment is used on the harvest site for only a short period of time. ... because clearcutting requires only temporary roads and infrequent operation of mechanical equipment, streams and soils can recover from the impacts of clearcutting through natural processes." (USDA, May 1992b, p.ii).

"Clearcutting ... most nearly matches the role formerly played by forest fires. ... is often considered the optimum method for regenerating aspen, lodgepole pine with serotinous cones, ... is also the most effective method for treating stands heavily infected with dwarf mistletoe, ... and is often the only practical method to use in stands of late successional species that have deteriorated to the point where there is an insufficient number of good trees for selection or shelterwood methods to be effective." (Burns, 1989, p.50).

The National Forest Management Act (NFMA) directs the agency to:

> Insure that clearcutting ... and other cuts designed to regenerate an even-aged stand of timber will be used as a cutting method on National Forest System lands only where
>
> > (i) for clearcutting, it is determined to be the optimum method ... to meet the objectives and requirements of the relevant land management plan.

The Report of the Committee on Agriculture and Forestry United States Senate on the National Forest Management Act of 1976, to accompany S. 3091, page 39 states:

> "The term optimum method means it must be the most favorable or conducive to reaching the specified goals of the management plan. This is, therefore, a broader concept than silviculturally essential or desirable, terms considered and rejected by the Committee. The Committee had substantial discussion over how to define when it was appropriate to use even-aged management systems. There was full agreement that the decision should not be based solely on economic benefits, i.e. dollar benefits or return dollars. Rather, the full scope of environmental effects (natural, economic, and social) should be evaluated and even-aged systems should be used only when they best meet forest management objectives for the individual management plan. Further, the monitoring, evaluation, and research processes will be used in the process."

The Chief of the Forest Service has established policy on clearcutting as follows:

> "Apply clearcutting only where it has been found to be the optimum method of regeneration to meet multiple-use objectives and is essential to meet forest plan objectives, involving one or more of the following circumstances:
>
> 1. To establish, enhance, or maintain habitat for threatened, endangered, or sensitive species.
> 2. To enhance wildlife habitat or water yield values or to provide for recreation, scenic vistas, utility lines, road corridors, facility sites, reservoirs, or similar development.
> 3. To rehabilitate lands adversely impacted by events such as fires, windstorms, or insect or disease infestations.
> 4. To preclude or minimize the occurrence of potentially adverse impacts or disease infestations, windthrow, logging damage, or other factors affecting forest health.
> 5. To provide for the establishment and growth of desired trees or other vegetative species that are shade intolerant.
> 6. To rehabilitate poorly stocked stands due to past management practices or natural events.
> 7. To meet research needs."

Determination of clearcutting optimality and adherence to the above policy will be decided on a project-specific basis and is not part of the forest plan.

Shelterwood

In the shelterwood system, "the next stand of trees is established through natural and/or artificial regeneration before the old one is completely removed. In a series of cuts, trees are removed, leaving the more desirable species and healthier trees to provide seed, protect the young seedlings, and increase in volume for the final cut. The three-step shelterwood process usually involves a series of three operations: (1) preparatory cuttings designed to stimulate seed production and prepare the seedbed; (2) seed cuttings to establish the new crop of trees; and (3) removal cutting to release the established seedling and harvest the overstory trees." (Burns, 1989. p.2). About one-third the volume of the stand is taken out in each of the above cuts. In the two-step shelterwood cut, usually just the seed production and removal cuts are completed, usually removing 40-60% of the volume in each cut. In an irregular shelterwood system, normally a three-step system, the last step or removal of the overstory trees is not accomplished. This creates somewhat of a two-storied or two-aged stand.

Coppice

The coppice system is very similar to clearcutting except that the future stand usually occurs from stump or root sprouting and residual, nonmerchantable trees are cut to promote sprouting.

Selection

In single tree or group selection, trees are removed either individually or in groups based on age, merchantability, health, seed production capability, and potential to increase in volume and quality. Single tree selection creates very small openings. In group selection, the openings can be up to two acres. Single tree selection is more favorable for reproducing species that can grow in the shade (shade-tolerant) over those that require direct sunlight. "Therefore the single tree selection method is not appropriate for regenerating shade-intolerant species." (Burns 1989, p.2). The size, shape, and placement of openings can be varied to meet the light requirements of the species being regenerated. Also, opening size is determined by the silvical characteristics of the trees, their size, and the ease in which they can be removed without damaging other vegetation.

"Silvicultural systems which cut only a few trees selectively throughout the forest require many entries in relatively frequent, short cycles of 20 to 25 years. Since entries are relatively frequent, roads to provide access to the forest must be made more or less permanent. Mechanical equipment used to cut and haul the trees from the site must access all parts of the forest every 20 years or so. The frequent use of mechanical equipment and permanent roads which now channel water runoff and result in small amounts of soil movement every year steadily impact soils and streams. Even though the impacts are relatively small each time, they occur faster than the processes though which soils and streams in the Rocky Mountains recover. So there is a small, steady, cumulative effect on soils and streams which can result in their long-term degradation." (USDA, May 1992, p.ii).